30 April 2015

English only

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Subsidiary Body for Scientific and Technological Advice
Forty-second session
Bonn, 1–11 June 2015

Item 5 of the provisional agenda
Issues relating to agriculture

Views on issues relating to agriculture

Submissions from Parties and admitted observer organizations

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its fortieth session, invited Parties and admitted observer organizations to submit to the secretariat by 25 March 2015 their views on issues relating to (a) the development of early warning systems and contingency plans in relation to extreme weather events and its effects such as desertification, drought, floods, landslides, storm surge, soil erosion and saline water intrusion; and (b) the assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local levels, including but not limited to pests and diseases. The SBSTA requested the secretariat to compile the submissions into a miscellaneous document for consideration at SBSTA 42.[1]

2. The secretariat has received six such submissions from Parties. In accordance with the procedure for miscellaneous documents, these submissions are attached and reproduced* in the language in which they were received and without formal editing.[2]

3. In line with established practice, the three submissions received from intergovernmental organizations and the six submissions received from non-governmental organizations have been posted on the UNFCCC website.[3]

---

[1] FCCC/SBSTA/2014/2, paragraph 86.

* These submissions have been electronically imported in order to make them available on electronic systems, including the World Wide Web. The secretariat has made every effort to ensure the correct reproduction of the texts as submitted.

[2] Also available at <http://unfccc.int/5901.php>.

[3] <http://unfccc.int/7482.php>.

FCCC/SBSTA/2015/MISC.1

GE.15-08642 (E)

1508642

Please recycle

Contents

		Page
1.	Chile (Submission received 31 March 2015)	3
2.	Latvia and the European Commission on behalf of the European Union and its member States* (Submission received 27 March 2015)	5
3.	Republic of Korea (Submission received 12 April 2015)	23
4.	South Africa (Submission received 7 April 2015)	26
5.	Sudan on behalf of the African Group (Submission received 21 April 2015)	30
6.	United States of America (Submission received 31 March 2015)	37

* This submission is supported by Albania, Bosnia and Herzegovina, Montenegro, Serbia, and the former Yugoslav Republic of Macedonia.

Paper no. 1: Chile

Submission by Chile to the Subsidiary Body for Scientific and Technological Advice (SBSTA) on the development of early warning systems and contingency plans in relation to extreme weather events and assessment of risk and vulnerability of agricultural systems to different climate change scenarios.

Chile welcomes this opportunity to share our experience on the development of early warning systems and contingency plans in relation to extreme weather events and assessment of risk and vulnerability of agricultural systems to different climate change scenarios, as requested by the document FCCC/SBSTA/2014/ L.14 of June 2014.

General context

Early warning systems allow to estimate the probability of occurrence of risky climatic events, generating information that supports governmental and private decision making in order to activate contingency plans to reduce the negative impacts of these events on harvests, productive systems, infrastructure and machinery. Besides, it is relevant to take into account indirect losses related to transportation systems, employment, and secondary industry, among others. Furthermore, early warning systems allow to increase the efficacy of mitigation measures and to reduce their implementation costs.

There is enough evidence to support that climate change is increasing the frequency and intensity of adverse climatic events, such as torrential rains, long droughts, frost, and hail, among others, threatening seriously the future development of the agricultural production systems, according to conditions of each country or local area. Moreover, the increase of temperatures is generating favorable conditions for the proliferation and outbreak of pests and diseases that will make agriculture productive systems even more vulnerable.

Having an adequate system for the assessment of risk and vulnerability can reduce the negative economic, environmental and social impacts of extreme events through measures to prevent or mitigate their effects. Information on vulnerability and risks allows for making appropriate decisions on crops, considering the right selection of species and varieties; planting and harvesting times; application of fertilizers and pesticides, among others.

Early warning systems and contingency plans are essential to ensure the sustainability of agricultural systems, safeguarding the food production capacity and welfare of those working in the field and other related activities.

Actions taken by Chile.

Chile is a highly vulnerable country to climate change effects. The area that concentrates agricultural production is already being affected by significant changes, with increased temperatures and reduced precipitation, accelerating desertification processes. As a consequence of these changes, arable areas and associated production systems are being moved to the South of the country, affecting the life´s cycle of current pests and diseases, and setting the condition for entrance of new ones. The reduction of glaciers is negatively altering the flow of rivers, with a direct impact on the availability of water for irrigation and human consumption.

To cope with this situation of greater uncertainty and risk, the country, through the National Unit of Agriculture Emergencies and Agro-Climate Risk, (*Unidad Nacional de Emergencias Agrícolas y Gestión del Riesgo Agroclimático*, UNEA), of the Ministry of Agriculture, is implementing on-line platforms with information that allow farmers to face more efficiently extreme weather events. For example, the Agro-Climatic website (http:// www.minagri.gob.cl/agroclimatico/) aims to concentrate most of all climatic

and meteorological information of interest to the agricultural and forestry sector; the **Agro-Climatic Observatory** (http://www.climatedatalibrary.cl/UNEA/maproom/) is designed for monitoring extreme weather events, seasonal forecasting and to have historical information (initially has indicators for drought); and the **National Agro-climatic network RAN** (http://www.agromet.cl/) that take information from 279 Automatic Weather Stations (EMAs), which delivers every hour the main meteorological parameters (rainfall, temperature, solar radiation, etc.). UNEA is also developing a frost surveillance system that operates in the months of highest occurrence of this phenomenon in order to provide timely information to farmers. Additionally, the UNEA, in collaboration with other institutions with competence in this area, especially the Meteorological Service of Chile (DMC) and the General Directorate of Water (DGA), organizes meetings every three or four months to inform the main representatives of the Chilean forestry and agriculture sector about the climatic situation.

Additionally, the Livestock and Agricultural Service (SAG) of the Ministry of Agriculture, has developed the platform **Bioclimatic Risk Modeling**, which is a system that allows modeling climatic parameters such as temperature, relative humidity, precipitation, wind, net radiation and pressure air on a digital elevation model (DEM) developed from ASTER images. The system is connected in real time to about 350 EMAS of the RAN and the DGA. This platform supports the **Phytosanitary Forecast Network** (RPF), which aims to generate timely information on optimal times for phytosanitary control of major pests.

In Chile, several studies on vulnerability have been financed by public resources, providing detailed information at farm level. In 2008, the study "*Análisis de Vulnerabilidad del Sector Silvoagropecuario y de los Recursos Hídricos y Edáficos de Chile frente a Escenarios de Cambio Climático*" ("Vulnerability Analysis for forestry and agricultural sectors, and water and soil resources of Chile in scenarios of climate change") provided important information on the risks and challenges imposed to the agriculture by climate change. It is important to update this report, in light of the 5th Assessment Report (AR5) of the IPCC.

Proposals to Parties for addressing this issue under the Convention.

1. Generate definitions for ***extreme weather events affecting agriculture***, and common criteria to evaluate their consequences at local, national and regional level.
2. Promote the development and implementation of coordinated actions among countries, particularly with neighboring countries or countries with similar conditions regarding extreme events such as flood, droughts, frosts and hails.
3. Generate early warning systems and contingency plans at national or sub-national level, as appropriate, and to establish, whenever possible, collaborative and compatible warning systems and contingency plans with neighboring countries or other countries that share common realities in terms of vulnerability to extreme meteorological events.
4. Parties could also promote the exchange of information and experiences regarding the reduction of the effects of extreme events on agriculture.
5. Develop systems to assess risk and vulnerability and early warning systems in relation to extreme weather events and pests and diseases outbreaks associated to climate change scenarios, promoting regional integration through developing compatible national systems and/or multinational systems allowing for joint actions to face biological risks associated to climate change.
6. Consider, according to national circumstances, establishing insurance systems in order to protect agricultural activities from extreme weather events, including systems to cover territorial catastrophes. Parties should also consider promoting collaboration in order to favor information exchange, technology transfer and capacity building, particularly in relation to institutional arrangements related to the implementation of these instruments.
7. Support the implementation of early warning systems and contingency plans in relation to extreme weather events and assessment of risk and vulnerability of agricultural systems to different climate change scenarios, facilitating the access to financial resources, technology transfer and capacity building, promoting north - south and south - south collaboration.

Paper no. 2: Latvia and the European Commission on behalf of the European Union and its member States

This submission is supported by Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Montenegro and Serbia.

Riga, 27 March 2015

Subject: Views on the development of early warning systems and contingency plans in relation to extreme weather events and assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local levels, including but not limited to pests and diseases.

General remarks

In line with the conclusions by the SBSTA chair[1], and on the occasion of 2015 being declared the International year of Soils by the General Assembly of the UN[2], and the publication of the European Union (EU) report on soils[3] earlier this year, the EU welcomes this opportunity to provide views on the first 2 themes agreed in the conclusions adopted by SBSTA 40 in 2014:
1) on issues relating to the development of early warning systems and contingency plans in relation to extreme weather events and their effects such as desertification, drought, floods, landslides, storm surge, soil erosion, and saline water intrusion as well as 2) on the assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, and national and local levels, including but not limited to pests and diseases. The EU would also like to re-emphasise the views expressed in its previous United Nations Framework Convention on Climate Change (UNFCCC) submissions on agriculture[4].

Issues and challenges related to agriculture

The findings of the IPCC's 5th assessment report (AR5), in particular with regards to agriculture, are cause for deep concern. The AR5 further substantiates how essential it is for global agriculture and food security to achieve our long term goal of limiting global temperature increase to less than 2°C compared to pre-industrial levels. Risks of negative impacts on crop yields will greatly increase above this threshold, some studies predicting yield reductions for major crops of up to 25% by 2050 while food demand continues to rise with a growing world population. The report also states that the impacts of heat waves, droughts, floods, cyclones and wildfires are all likely to increase. Yet the report also identifies key adaptation actions for reducing the risks and minimising adverse impacts on the agriculture sector, one of these being the development of early warning systems for extreme events.

---

1 http://unfccc.int/resource/docs/2014/sbsta/eng/l14.pdf
2 http://www.fao.org/soils-2015/en/
3 http://eusoils.jrc.ec.europa.eu/
4 http://unfccc.int/resource/docs/2012/sbsta/eng/misc06.pdf
http://unfccc.int/files/land_use_and_climate_change/redd/submissions/application/pdf/20130903_subm_eu_agriculture_sbsta39_rev.pdf

The AR5 highlights that approaches for managing the risks of climate change associated with sustainable agriculture should be considered complementary rather than apart from each other as they are often pursued simultaneously. Approaches to adaptation shall include mitigation therefore, since significant co-benefits, synergies, and trade-offs exist between mitigation and adaptation and among different adaptation responses.

Adaptation in agricultural systems plays a key role for all countries, in particular for those most vulnerable to the impacts of climate change. The linkages between climate change mitigation and adaptation to food security need to be addressed urgently in order to help reduce the ambition gap towards the 2°C objective and contribute to sustainable development and food security. Large scale national and international commercial land transactions should also be addressed to ensure sustainable development. In this regard, the principles of responsible investments in agriculture would support sustainability as well as focusing the challenges of climate change. Delayed action to tackle climate change will narrow the options for effectively reducing emissions and preparing for the impacts of climate change. Opportunities to take advantage of positive synergies between adaptation and mitigation may decrease with time and related costs will increase. While what constitutes an intolerable risk may differ nationally and regionally depending on national circumstances, it is essential that all climate action opportunities to avoid eroding the basis for sustainable development are considered. Correspondingly, agriculture and forest policies should integrate both mitigation and adaptation more effectively.

Climate change impacts are becoming apparent in the EU, where for example farmers in the different member states are already experiencing the impacts of severe weather events such as droughts, floods, and land-slides. Climate change can for example cause decreasing wheat yields in parts of Europe and also adversely affect dairy production because of heat stress in lactating cows. Climate change has already contributed to vector-borne diseases in ruminants and in a northward expansion of tick disease vectors. It will increase irrigation needs but future irrigation will be constrained by reduced runoff, demand from other sectors, and by economic costs. As a result of increased evaporative demand, climate change is likely to significantly reduce water availability from river abstraction and from groundwater resources. Future agricultural irrigation is therefore likely to be constrained by demand from other sectors, and by increased economic costs.

The EU believes that more work on adaptation in agriculture is needed in all countries, including in the EU. Implementation of early warning systems and contingency plans in relation to extreme events, and the assessment of vulnerabilities of agricultural systems are needed to prevent and reduce climate change impacts on agriculture.

The EU is taking action both domestically and internationally. In the international context the EU fully supports the WMO initiative under the Global Framework on Climate Services which has established Agriculture and Food Security as a priority area (http://gfcs.wmo.int/). Under the Copernicus programme the EU has been leading in the development of observations for land monitoring and climate change (www.copernicus.eu/). These systems are in development and the EU wishes to work with local stakeholders to enable the provision of tailored information for decision making.

A set of case studies is presented in the submission to illustrate the type of action engaged by the EU (see following boxes). More details on these initiatives are contained in the annexes to this submission.

Climate Change in Spanish Coasts:
Due to the importance of coastal agriculture in many regions in Spain, this study is relevant for the agricultural sector. Agriculture is considered as a coastal socio economic system, together with infrastructures, settlements, tourism and fisheries, but is also considered as a component of the natural system with regard to impacts of climate change. This project has been replicated for Latin-America and the Caribbean through the "Regional study on the effects of climate change on the coasts of Latin America and the Caribbean (C3A)"

Monitoring grass from space: to help establish early warning systems for future fodder crises in Ireland.

Assessing climate change impacts for local development planning in West Africa
Supported by France and the EU, this programme is coordinated by Aghrymet[5] (Niger) and implemented in 10 countries across West Africa to assess climatic risks, impacts, vulnerabilities and possible solutions for subsistence farming. The participatory approach involves farmers, herders, community leaders and vulnerable groups like women, and contributes to capacity building and local development planning.

Austrias Adaptation Strategy: ClimGrassEco:
This project aims at increasing understanding of complex processes and functional relations in grassland eco-systems under changing climate conditions as a basis for developing measures and adaptation strategies for grassland management, strengthening the manifold ecosystem services of grassland ecosystems.

Austrian Climate Research Programme AgroDroughtAustria:
The aim of this project is to develop and test a crop specific operational drought monitoring and forecasting system for agriculture in Austria. The objectives include the establishment and calibration of indicators and methods on crop specific drought and heat vulnerability and impacts based on field experiment data and crop model application. Further, a high spatial resolution model for crop drought and heat stress assessment will be applied.

[5] Created in 1974, AGRHYMET is a specialized agency of the Permanent Inter-State Committee against Drought in the Sahel (CILSS) governed by thirteen countries in west Africa : Benin, Burkina Faso, Cape Verde, Chad, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mali, Mauritania , Niger, Senegal and Togo.

Agro-ecology and emission reduction in Paraguay:
The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management supports the implementation of agro-ecological practices and sustainable forestry in six local communities in Paraguay. The project aims at promoting the self-sufficiency of the communities and the reduction of emissions. It includes trainings on the commercialization of products and workshops on institutional issues.

Multilateral Case Study: Adaptation for Smallholder Agriculture Programme
EU Member States (Belgium and Flanders Government, Finland, France, the Netherlands, Sweden, and the UK) are providing support of about EUR€ 301 million to the International Fund for Agricultural Development's Adaptation for Smallholder Agriculture Programme (ASAP). ASAP is the largest global adaptation agriculture programme and is expected to help at least 8 million smallholder farmers build their resilience to the impacts of climate change while delivering economic impacts and mitigation benefits.

Long-term adaptation to climate change in viticulture and oenology in France (LACCAVE project): Conducted by INRA[6], this applied research project develops a global vision of the wine supply and value chain that analyzes both the impacts of climate change and the diversity of adaptation levers that can be used by all actors in the chain. This analysis is performed at a range of scales (plant, plot, farm, regional terroir) with a focus on the terroir scale, which can be used to develop a multi-actor governance of changes.

Irish Aid programme examples of Climate Smart Agriculture programmes in Key Partner Countries:
Ethiopia - to enhance food security, improve nutrition and adapt to climate change through better access to drought resistant crop varieties, animal breeds and management techniques.
Malawi - to support the National Association of Smallholder Farmers in Malawi (NASFAM) agricultural programme which aims for sustainable and profitable farming that can help poverty alleviation and build agricultural productivity resilience to climate change included training of 'lead farmers', who then share new knowledge.

[6] INRA: French Agronomic National Research Institute

The following figure is providing an overview of climate related risks in Europe that will affect our farmers:

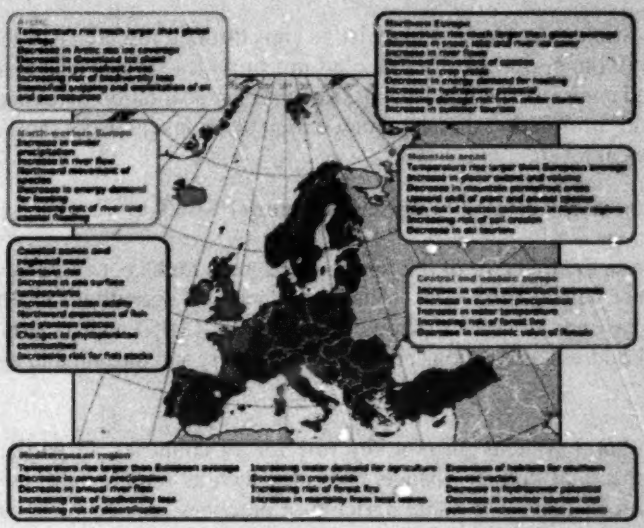

Figure1: Observed and projected climate change risks in Europe (source: EEA 2012, Climate change, impacts and vulnerability in Europe 2012)

In the EU there are a number of policy instruments assisting farmers in dealing with various types of risk. These policies have evolved over time, at both the national and the Union level, (see Annex 1). Rural Development Policy[7] as part of the European Common Agriculture Policy (CAP) provides for:

- Risk management support
- Crop, animal and plant insurance
- Mutual funds for adverse climatic events, animal and plant diseases, pest infestations and environmental incidents
- Income stabilisation tools in cases of exceptional drop of farmers' income
- Cross Compliance for Good Agricultural Environmental Conditions (GAECs)

Therefore the CAP (including RDP pillar 2) provides a toolbox of measures to address both adaptation responses to climate impacts to improve agricultural resilience; and opportunities to enhance resource efficiencies in the sector. Member states can select measures to address their own specific needs providing flexibility to take account of diverse practices; regional and local conditions; wider policy objectives, ranging from environmental issues to food security.

[7] http://ec.europa.eu/agriculture/rural-development-2014-2020/legislation/index_en.htm

Furthermore, one of the four headings of the current European Framework Programme for Research and Innovation (HORIZON 2020[8]) focuses on increasing agricultural production efficiency and coping with climate change, while ensuring sustainability and resilience.

The EU Adaptation Strategy[9] addresses knowledge gaps through research and the European climate adaptation platform (Climate-ADAPT). This platform provides several useful resources to support adaptation policy and decision making, such as: a toolset for adaptation planning; a project and case studies' database; and information on adaptation action at all levels, from the EU through regional and national to the local level.

Scope of the work on issues related to agriculture under SBSTA[10]

This submission covers the first two of the four topics agreed in the conclusions adopted by SBSTA 40 in 2014[11], and that will be addressed in the workshops on agriculture in Bonn (SBSTA 42, in June 2015), and in two additional workshops in June 2016 (SBSTA 44). This programme of the four workshops will address adaptation, but also co-benefits, and sustainable agricultural practices and technologies.

Adaptation in agricultural systems plays a key role for all countries, in particular for those most vulnerable to the impacts of climate change, as issues such as food security need to be addressed urgently and it is crucial that sustainable agriculture practices are identified and disseminated in order to contribute to sustainable development and food security. This in turn also helps reducing the ambition gap towards the 2°C objective.

In the EU's view, the SBSTA work on agriculture is an ideal opportunity to highlight technical solutions and policy options for agriculture that contribute to climate resilient and low emission sustainable development for all countries. The EU believes that such low carbon and climate resilient development will have to be designed at national or subnational level, as there is a need for tailor-made policies and measures that take into account agro-ecological zones, specific circumstances and production systems, and local climate risks and vulnerabilities. Nevertheless, sharing international expertise and best practices will greatly facilitate national and subnational policy design and implementation.

The EU thinks that there is the need to take stock of all relevant initiatives and work conducted at national, regional or international level on those issues, particularly by international networks and organizations such as CCAFS[12], FAO[13], IFAD[14] , and to compile work already done under the UNFCCC relevant to this topic (i. e. from the Nairobi Work Programme). Collaboration with other UN organisations on this such as UNCCD[15], UN Water[16], UNISDR & the Hyogo Framework[17], WMO[18], UNEP[19] and FAO is also encouraged.

---

[8] http://ec.europa.eu/programmes/horizon2020/en/area/agriculture-forestry
[9] http://ec.europa.eu/clima/policies/adaptation/what/index_en.htm
[10] Decision 2/CP.17 paras 75-77
[11] http://unfccc.int/resource/docs/2014/sbsta/eng/l14.pdf
[12] CGIAR Research Program on *Climate Change, Agriculture and Food Security* (*CCAFS*) www.ccafs.cgiar.org
[13] United Nations Food and Agriculture organization (FAO) www.fao.org
[14] International Fund for Agricultural Development (IFAD) www.ifad.org
[15] United Nations Convention to Combat Desertification (UNCCD) www.unccd.int

Moreover, many countries have manifested their interest in the agricultural sector in relation to climate change. Most of the measures in existing national adaptation plans are directly related to the agricultural sector. Given the importance of agriculture for economies, including in the EU, agriculture is a key component of national adaptation planning.

The 2015 and 2016 workshops on agriculture are an important first step. The EU's view is that in the future this SBSTA agenda item should provide a wider contribution on the following issues:

1. Technical issues

- Review the evidence base; observed and projected impacts of climate change on agriculture, socioeconomic impacts across regions and agricultural systems.
- Review of technical and organizational innovations (practices, technologies, production systems, policies) and analysis of further technical needs; possible synergies and trade-offs for adaptation, mitigation and sustainable increase in productivity efficiency.
- Climate change in relation to food systems, encompassing production, transportation, storage, retail and food consumption, including food waste and food losses.
- To improve the understanding of the interactions and synergies of climate actions that promote sustainable agricultural and land management practices especially those that are triple win improving incomes, resilience and resource efficiency.
- Review of technical and organizational innovations (practices, technologies, production systems, policies) and analysis of further technical needs; possible synergies and trade-offs for adaptation and mitigation

2. Social issues

- Consideration of the role of local producers (local communities and indigenous peoples) applying environmentally and climate friendly agriculture and supplying local markets.
- Awareness of gender issues related to agriculture and climate change.
-

3. Action at national, regional, and international level

- The use of landscape approach to ensure coherence between policies in agriculture, nature conservation and sustainable management of forests, particularly in countries where deforestation and forest degradation are mainly driven by agricultural expansion and increased vulnerability (degraded lands, increased demographic pressure...).
- Exchange on methodologies for vulnerability assessment at field, farm, landscape and value-chain levels and development of metrics linking adaptation, mitigation and food security.

---

[16] United Nations inter-agency coordination mechanism for all freshwater and sanitation related matters (UN Water) www.unwater.org
[17] United Nations International Strategy for Disaster Reduction *(UNISDIR)* www.unisdr.org
[18] World Meteorological Organisation (WMO) www.wmo.int
[19] United Nations Environment Programme (UNEP) www.unep.org

- Identification of opportunities and barriers for enhanced action at national level, addressing in particular possible trade-offs between climate, environmental (nature conservation) and development policies.
- Cooperation with existing UNFCCC agenda items (NAMAs, NWP, Adaptation Committee, CDM, REDD+, LEG, etc.) building on their work and knowledge gathered in relation to the issue of agriculture.
- Assessment of existing UNFCCC tools (NAMAs, NAP Process, NAPAs, CDM, REDD+, CTCN, capacity building...), their potential and limits in agriculture, and the possible need for additional incentives to foster action on climate change.

Purpose and Scope of the two June Workshops on issues related to agriculture

1. Objectives of the two workshops

In the EU's view, the workshops shall focus on the mandate of SBSTA conclusions (FCCC/SBSTA/2014/L.14), that is, **to undertake scientific and technical work**

1) … in the development of early warning systems and contingency plans in relation to extreme weather events and its effects such as desertification, drought, floods, landslides, storm surge, soil erosion, and saline water intrusion and

2) … in the assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local levels, including but not limited to pests and diseases.

Through the workshops Parties and other participants shall exchange experiences, best practices, discuss opportunities and challenges, share lessons learned and facilitate cooperation among Parties.

The EU is of the view that the work should be focussed and structured in a way that discussions are carried on in an effective way.

2. Potential participants

In addition to the participation of representatives from Parties to the Convention, the active participation of relevant experts in the technical process should be encouraged. The Secretariat shall secure the engagement of appropriate related bodies and institutions, such as FAO, UNISDR, CTCN, other relevant UN bodies and funds, such as the Adaptation Fund, in the Workshops. Civil society, private sector, especially farmers' organizations and representatives of local communities and indigenous peoples engagement is also crucial in order to have successful discussions and obtain a more accurate global picture in relation to this topic.

3. Structure

The workshops should be organized in a way that supports discussions and effective and efficient exchange of views among participants. Parties and relevant organisations should be encouraged to share experiences, best practices and lessons learnt ensuring an interactive exchange of views and

debates with other participants. The workshops shall ensure sufficient time for discussion of possible conclusions or outcomes of the workshops.

4. Content

The workshops should provide guidance and knowledge that support countries trying to identify technical and political options regarding the design of policies relevant to the development of early warning systems and contingency plans and to the assessment of risk and vulnerability of agricultural systems as described in the SBSTA conclusions (FCCC/SBSTA/2014/L.14).

As a first step, the Secretariat should give a presentation on what is already taking place in the United Nations arena, particularly under the Convention. Therefore, the EU suggests that the UNFCCC Secretariat presents a stocktaking of those bodies, actions, tracks, works, etc., under UN that have experience related to these issues (FAO, UNISDR, work on NAPAs, NAP Process, NWP, LDCF, AF,...).

Secondly, on the basis of the overview presented by the Secretariat, it would be beneficial to all parties to get more details on e.g. how to facilitate Parties' access to databases, financing, best practices, etc. Therefore, this part should focus on:

- IPCC 5AR results in this regard
- Existing data bases
- Available scenarios at national, regional or local levels or means to promote and facilitate their development
- Existing tools for development of early warning systems and contingency plans
- Existing fora for exchanging views on early warning systems and contingency plans
- Tools and instruments to assess risk and vulnerability of agricultural systems
- Existing research initiatives and review of technical and organizational innovations

The third part should provide information on elements required for the development of early warning systems and contingency plans and for the assessment of risk and vulnerability of agricultural systems:

- Technical and technological needs: Research and systematic observation, databases, collaboration and coordination of technical bodies (in particular, national hydrological and meteorological services), models, etc.
- Governance structures

A fourth section of the workshop should focus on existing experiences on the ground (to be presented by countries (see annex 1 for some relevant case studies from EU and its member states) regional organizations or other relevant institutions), such as:

- Concrete experiences in countries/regions
- Barriers and difficulties, and how to overcome them.
- Opportunities and elements for success

- Practical experiences with gender issues, local producers, synergies with sustainable agriculture and land management practices

Finally, there should be time to discuss the conclusions and outcomes of the workshops.

5. The report

The secretariat has received the mandate to elaborate a report for each of the workshops. This report should provide an overview of the presentations and discussions on the topics of the workshops, as enunciated by the SBSTA chair[20], but also reflect on tools identified, the identification of needs and priorities, of bodies, institutions, organizations that work on these issues and any other relevant information that could be of interest for Parties and other stakeholders.

[20] http://unfccc.int/resource/docs/2014/sbsta/eng/l14.pdf

ANNEXES

Annex 1 – EU policy instruments, research and other efforts

- The Commission adopted an EU adaptation strategy in April 2013 which has been welcomed by the Member States. Complementing the activities of Member States, the strategy supports action by promoting greater coordination and information-sharing between Member States, and by ensuring that adaptation considerations are addressed in all relevant EU policies.
- Concrete examples of measures include:work on crop rotation, sowing dates, crop varieties, planting of hedgerows or small wooded areas, standards for irrigation practices, helping them adapt farm structures and production methods. Farmers get support helping them continue to provide services for the rural environment, keep informed about climate risk and by providing them with advisory services and training.
- For more information please see http://climate-adapt.eea.europa.eu/agriculture-and-forestry

- In the CAP 2014-2020, environmental and climate concerns are integrated for the support of adaptation to climate change, even though the main focus is on mitigation activities:
- Part targeted cross-compliance mechanism, specific rules for soil management apply to all farmers, the maintenance of soil organic matter, fight against erosion and minimum soil cover.
- The rural development programmes offer many possibilities for member states and regions to address climate change mitigation and adaptation:
- (a) increasing efficiency in water use by agriculture
- (b) increasing efficiency in energy use in agriculture and food processing;
- (c) facilitating the supply and use of renewable sources of energy, of by-products, wastes and residues and of other non food raw material, for the purposes of the bio-economy;
- (d) reducing green house gas and ammonia emissions from agriculture;
- (e) fostering carbon conservation and sequestration in agriculture and forestry;
- training and information actions, cooperation projects, innovative actions will also be promoted under rural development, including for climate mitigation.

- Coordination of research topics across Member States through the EU Horizon 2020 programme, including research on risks and threats for agricultural production.

- The Modextreme project tries to help the European and non-European agriculture to face extreme climatic events by improving the capability of biophysical models simulating vegetation responses to integrate climatic variability and extremes.

- A research project whose purpose is to support adaptation planning through building the knowledge base on the economics of adaptation to climate change and converting this into practical information for decision makers.

Annex 2: MS national case studies and good practices

Climate Change in Spanish Coasts (C3E).

Spain is a Peninsula, with around 8.000 Km of coast, therefore, coastal systems have been prioritized in the analysis of climate change impacts and adaptation.

The C3E:

- analyses the coastal systems in Spain (natural and socioeconomical systems)
- identifies drivers
- provides scenarios for projections (including climate and non climate – vulnerability-scenarios)
- analyses the impacts of climate change on coastal systems (observed and projected impacts)
- reflects on the consequences of climate change in Spanish coasts

Due to the importance of coastal agriculture in many regions in Spain, this study is relevant for the agricultural sector. Agriculture is considered as a coastal socio economic system, together with infrastructures, settlements, tourism and fisheries, but is also considered as a component of the natural system with regard to impacts of climate change.
In this study, saline intrusion in agricultural lands has been one of the impacts that have been already observed in some agricultural systems, and it affects the natural and socio economic aspects of these lands. The risk analysis for the future under this research, that takes into consideration risks for population, flooded areas and economic valuation to the different elements that are analyzed, estimates the damages caused by the rise in sea level or extreme events of flooding in the horizon year (2050 or 2100) in all the sectors under analysis, including agriculture. More information can be found in the report:
http://www.magrama.gob.es/es/cambioclimatico/temas/impactos-vulnerabilidad-yadaptacion/plan-nacional-adaptacion-cambioclimatico/Z_costeras.aspx

This Study also provides a cartographic viewer, where any interested person can have free access to all the background data and databases:
http://www.c3e.ihcantabria.com/

C3A: Climate Change in Latin American and Caribbean coasts

Since the experience with this work has been very positive, it has been replicated for Latin-America and the Caribbean through the "Regional study on the effects of climate change on the coasts of Latin America and the Caribbean (C3A)" The study provides, among other results, risks maps, that take into account the different hazards, coastal land uses (including croplands), adaptation and capacity measures, vulnerability indicators, etc.
These results complement the regional economics of climate change studies (RECCS), whose technical aspects are coordinated by ECLAC. RECCS examine the impacts of climate change on agriculture, infrastructure, health and ecosystems, helping the countries to identify the implications of climate change for their economies and societies.
The "Regional study" includes six publication four main publications and two supporting documents at
http://www.cepal.org/id.asp?id=48025
and a web viewer for georeferencing selected indicators at
http://www.c3a.ihcantabria.com/.

Monitoring grass from space

Following a depletion of fodder stocks brought on by poor weather in the summer of 2012 and the late arrival of good grass growing conditions in 2013, due to the abnormally cold spring period Ireland encountered a animal fodder crisis.

As a consequence the Spatial Analysis laboratory in Teagasc, with partners in the Department of Geography, UCC, are developing new tools to estimate grass growth in Ireland using satellite imaging. The satellites used here observe grass growing across the country, combining these observations of the current status with the grass growth models developed in the grass research programme and local meteorological forecasts will enable us to predict how grass will grow across the country at parcel scales for days or even weeks ahead. Monitoring grass-growth trends will enable us to give the status of the national crop. This, in turn, will help establish early warning systems for future fodder crises (by detecting a poor autumn harvest or identifying and forecasting a late spring). It is hoped that an Agri Metrological service based on this research will be launched this spring (2015) initially helping with herd management, paddock planning and fodder planning. Then local grass growth forecasts (2day, 4day, 8day) will be available in much the same way as agricultural weather forecasts are, and be as useful.

Reducing CO2 emissions from rural areas and strengthening Indigenous Peoples and Peasant Communities Rooting through Agroecology:

The Environmental Department of the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management supports a project in six local communities in Paraguay aiming at implementing agro-ecological practices and reducing emissions from agriculture and forest management. The initiative has a strong participative character. The situation in every community was extensively discussed in the frame of participative workshops at the beginning of the project. The participants also decided on the kind of practices that they want to implement. The six communities are located in areas affected by soy expansion. Thus, the project seeks to support agriculture and forestry alternatives that contribute to a reduction of emissions and strengthen the resilience of the communities. It encompasses among other activities: Setting up a seed production strategy and demonstrative production plots, implementation of a simplified forest inventory as well as an inventory of seed varieties, development of a participatory forest, water and soil management plan, setting up tree nurseries, implementation of soil conservation activities, training on food preservation techniques, diversification of agricultural production and support for the commercialization of the products, trainings on ethnic and human rights as well as on economic, social, cultural and environmental rights guaranteed by the Constitution of Paraguay. The project is being implemented by the Centro de Estudios e Investigaciones de Derecho Rural y Reforma Agraria (CEIDRA) in cooperation with Servicio Nacional de Calidad y Sanidad Vegetal y de Semilla (SENAVE), Institutio Paraguayo del Indígena (INDI) and Instituto Forestal Nacional (INFONA).

Assessing climate change impacts for local development planning in West Africa (France and EU)

Addressing the issue of adaptation of the agricultural sector to climate change is critical both at national and local level. It is particularly true in sahelian countries, given the weight of agriculture in GDP, between 20 and 50 %. In this context, linking research results and action on the field can help to improve investments for adaptation and their inclusion in local development plans.

Agrhymet[21] Regional Center is a research institute based in Niger, focusing on climate change, land degradation and food security issues in West Africa. It implements two main projects on climate change, funded by the EU (Global climate change alliance) and the French fund for global environment. These projects have supported a master degree training on climate change and sustainable development targeting public and private professionals from the 17 countries of the West African region. This master includes a 6 months period on the field, in rural communities. This training period aims to improve the understanding of climate variability at local level, and further propose solutions for the adaptation of rural communities to climate change.

Risks are addressed by the analysis of rainfall and temperature data on the long term. Sixteen students have experimented this approach, in 10 countries across West Africa. It combines tools designed by the World Bank Institute, GIZ and CARE, a NGO. A set of matrixes focusing on climatic risks, impacts and solutions is used. Climatic Rain shortages, floods, temperature peaks, violent winds and their frequency are described. The results are then compared to the local perception of climate variability. As a second step, the impacts of the main climate risks on local activities like rainfed agriculture, irrigated agriculture, livestock, and forestry are listed. The level of vulnerability of the different stakeholders is also measured, according to their power of resilience, on the economic, social and environmental sides. The last step consists in choosing adaptation solutions for each sector. Matrixes are filled in, with a participatory approach, at each step of the process.

This capacity building of various actors at local level, including agricultural producers, herders, community leaders and vulnerable groups like women, enables to propose a set of solutions to better adapt to climate change. In most cases, projects focusing on local development have embedded this work, taking the results into account for action planning. Huge projects like the PAC (projet d'actions communautaires) of the World Bank in Niger are interested by the approach. It will be also presented during workshops at national level, in Niger, Benin and Burkina Faso targeting mayors via their national platforms. This process of sensitization will continue in the others countries of West Africa in the medium term.

[21] Created in 1974, AGRHYMET is a specialized agency of the Permanent Inter-State Committee against Drought in the Sahel (CILSS) governed by thirteen countries in west Africa : Benin, Burkina Faso, Cape Verde, Chad, Ivory Coast, Gambia, Guinea, Guinea Bissau, Mali, Mauritania, Niger, Senegal and Togo.

Multilateral Case Study: Adaptation for Smallholder Agriculture Programme

Agriculture is one of the sectors most seriously affected by climate risks, and is important for developing countries' economic growth, food and nutrition security, and poverty reduction. Climate change puts these at risk. The International Fund for Agricultural Development (IFAD) has responded to this challenge by developing the Adaptation for Smallholder Agriculture Programme (ASAP). This is supported by several EU Member States (Belgium and Flanders Government, Finland, France, the Netherlands, Sweden, and the UK) in total around US$ 320 million.

The Adaptation for Smallholder Agriculture Programme (ASAP) channels climate finance to smallholder farmers so they can access the information, tools and technologies that help them build their resilience to climate change. Launched by IFAD in 2012, ASAP has become the largest climate change adaptation programme and is expected to help at least 8 million smallholder farmers to build their resilience to the impacts of climate change while delivering economic impacts and mitigation benefits. ASAP now supports 35 developing countries around the world, through dedicated grant financing for actions to manage growing climate risks. In 2013 recognition of its work on ASAP IFAD won a Momentum for Change Lighthouse Activity award announced by Ban Ki-moon, the UNSG, for its innovative work on adaptation and use of climate finance.

Further details on ASAP can be found on http://www.ifad.org/climate/asap/index.htm

Irish Aid programme examples of Climate Smart Agriculture programmes in Key Partner Countries:

Ethiopia

In Ethiopia, the Irish Aid programme supports an Operational Research (OR) programme to enhance food security, improve nutrition and adapt to climate change through better access to drought resistant crop varieties, animal breeds and management techniques. Low annual rainfall and frequent drought makes farming difficult for Ethiopian communities. However, through the Operational Research programme, farmers have come together to form 'Farmers Groups', jointly identifying new seed varieties to improve crop performance and taking new agricultural technologies to scale through seed exchange and farmer field days.

Irish Aid also supports ICRAF and the regional Agriculture Ministry to add value to Irish Aid's previous watershed management engagement in Ethiopia's northernmost region of Tigray, with sustainable and profitable farming that can help poverty alleviation and climate change resilience, as well as agricultural productivity. To achieve this, NASFAM is spreading Conservation Agriculture knowledge among 100,000 farmers across 19 districts. Technologies involved included the development of Guidelines for Conservation Agriculture in Malawi through the National Conservation Agriculture Task Force, support to ICRISAT's research into, multiplication and provision of quality climate adapted seeds and planting materials and highlighting pit mulching & total ground cover technologies. The programme also included training of 'lead farmers', who then share new knowledge, provision of advice to farmers on getting better prices in domestic & global markets and building farmers knowledge on climate resilience.

In the growing season of 2014/15, ICRAF, with support from Irish Aid and in collaboration with the Government of

reforestation including fertiliser trees. Through improving soil and water conservation and vegetation cover, access to improved groundwater supplies and irrigation will be safeguarded. The gains to protect can be significant. In the Gerghera watershed, crop productivity increased by as much as 40 percent, and feed availability for animals has more than doubled.

Malawi
Irish Aid supports the National Association of Smallholder Farmers in Malawi (NASFAM) agricultural programme which aims for Malawi are pilot-testing the inclusion of fertilizer trees in the Farm Input Subsidy Program (FISP) in Dedza district. The pilot-test will involve 10,000 farmers. This is the first time farmers have received fertilizer tree seeds as one of the additional inputs under the FISP package. In a 'Fertilizer Trees' and Malawi's New Food Security Initiative research conducted in Malawi, the study revealed that combination of inorganic fertilizers and fertilizer trees have shown positive beneficial effects on organic amendments to soils and maize yield performance.

Long-term adaptation to climate change in viticulture and oenology in France (LACCAVE project - INRA[22])

Wine production in Europe accounts for more than 60% of the global total and makes an important contribution to cultural identity. Apart from impacts on grapevine yield, higher temperatures are also expected to affect wine quality in some regions and grape varieties by changing the ratio between sugar and acids. Earlier harvest dates, exacerbated water shortages for vines, more alcoholic wines, with new flavor profiles are already observed in France as a result of climate change. These impacts are very likely to increase through time, with positive or negative economic consequences that may vary across vineyards. Adaptation measures are already occurring in some vineyards (e.g., vine management, oenological changes, production control, and to a smaller extent relocation). Vineyards may be displaced geographically beyond their traditional boundaries ("terroir" linked to soil, climate, and traditions) and, in principle, wine producers could adapt to this problem by growing grape varieties that are more suited to warmer climates. However, such technical solutions do not account for the unique characteristics of wine production cultures and consumer perceptions of wine quality that strongly affect the prices paid for the best wines. To develop adaptation options, the project assesses the effects of climate change on vines and wines, explores coping strategies and proposes scenarios for the French wine regions. Multiple solutions are studied, including advanced mapping of microclimate, precision irrigation and adaptation of yeast breeds used for wine making. The changing consumer preferences and changes in the wine regulations are also taken into account as they influence the winemaker's adaptation strategies. The project develops a global vision of the supply chain and of the value of the wine that analyzes both the impacts of climate change and the diversity of adaptation levers that can be used by all actors in the chain. This analysis is performed at a range of scales (plant, plot, farm, regional terroir) with a focus on the terroir scale, which can be used to develop a multi-actor governance of changes.

[22] INRA: French Agronomic National Research Institute

Austrian Climate Research Programme AgroDroughtAustria

This project is funded by the Climate and Energy Fund (KLIEN) within the "Austrian Climate Research Programme" (ACRP 5th Call).

Drought is one of the main risks for agricultural crop production and food security worldwide. In-creasing droughts and serious consequences for agricultural production are expected under climate change conditions also in Central European regions including Austria as reported by several studies. Therefore monitoring systems for drought risk, severity or impacts are often named as an important adaptation option in order to reduce vulnerability and improve resilience to drought, especially in the field of agricultural crop production. In order to assess drought affected areas spatial operational drought monitoring systems are already in use worldwide, however, mostly in a relatively general level regarding spatial resolution or identifying specific impacts to various recipients (such as specific crops).

In order to improve related information on the status of drought (including forecasting) for stakeholders, however, there is a strong need to identify and describe specific impacts on a local level. The aim of the project AgroDroughtAustria is therefore to develop and test a crop specific operational drought monitoring and forecasting system for agriculture in Austria. The objectives include the establishment and calibration of indicators and methods on crop specific drought and heat vulnerability and impacts based on field experiment data and crop model application. Further, a high spatial resolution model for crop drought and heat stress assessment will be applied by using improved spatial precipitation and temperature input (INCA data) combined with a near-time (up to 10 days) forecast. In specific, the methods for crop drought and heat stress detection are implemented in a GIS-based monitoring system with high spatial resolution (1x1km) for the main vulnerable arable crops of Austria. The drought monitoring system will be tested in selected case study regions including stakeholder participation.

Austrias Adaptation Strategy ClimGrassECO

This project is funded by the Federal Ministry of Agriculture, Forestry, Environment and Water Management, aiming at following overall objectives:

- Detailed understanding of complex processes and functional relations in grassland eco-systems under changing climate conditions
- Development of causally determined measures and adaptation strategies for grassland management
- Maintenance and protection of the manifold ecosystem services of Impact of future climate conditions on productivity and biogeochemistry of grassland ecosystems grassland

Based on the existing experimental facility, the planned project structure and the multidisciplinary collaboration fundamental

It will account for interactions between carbon, nutrient and water cycles and the central role of the biota governing the processes.

By pursuing a combination of response surface and factorial experimental designs ClimGrassEco aims to unravel mechanisms underlying non-additive and non-linear responses of grassland biogeochemistry to multiple climate change factors.

ClimGrassEco is based on a comprehensive field experiment with in total 54 plots, which are equipped with infrared heaters, CO2-fumigation rings and additionally with monolithe lysimeters and rain-out shelters for selected factor combinations. The overall concept and experimental design of ClimGrassEco has been highlighted in a previous international project review as "world-class facility". Furthermore on eight

and relevant findings may be expected.

The project "Impact of future climate conditions on productivity and biogeochemistry of grassland ecosystems" (ClimGrassEco) aims to quantify and understand individual and combined effects of warming, elevated CO2 and summer drought on yield, forage quality, botanical composition and several biogeochemical processes in permanent grassland.

plots grassland monoliths (in total 48 mesocosmos with 30 cm diameter, 60 cm depth) are installed to perform fertilisation experiments in situ. Beside of invasive yield analysis several non-invasive methods (ultrasonic sound, spectrometry, SPAD-meter) are used to explore growth dynamics.

Korea's Views on the Development of Early Warning Systems in Relation to Extreme Weather Events

Background

Agriculture is a fundamental supply source of food for the human race. Since mankind started crop cultivation, they settle down in one place and formed its own unique civilization. To put it another way, farming ended mankind's nomadic life because it is impossible to transport arable land. Due to the 'unmovable' feature of agriculture, it is acutely dependent on the natural environment, and certain weather patterns regularly affect specific areas.

Recently, climate change has made the weather dependency of agriculture more dramatic. Climate change has increased the frequency of weather extremes and, in some region, led to serious damages in agriculture. While climate extremes occur at differing levels, alleviating their damaging effects is only possible on a limited and restrictive scale.

In this context, the Agro-meteorological Early Warning System only works properly when the system is firmly built on accurate and site-specific-agricultural information. The existing systems often lack site-specific data on adverse weather events. The particular circumstances of farmlands are not reflected in the system. Furthermore, the mechanisms do not consider the 'chronic long term effects' of adverse weather events or the combined effects of two or more weather elements.

In this regard, the National Academy of Agricultural Science (NAAS) under the Rural Development Administration (RDA) in Korea has designed a risk management solution for individual farms that are threatened by the detrimental impacts of climate change.

The Fundamental Concept of the Agro-Meteorological Early Warning Service System

The purpose of the Agro-meteorological Early Warning System is to develop tailor-made risk management solutions for individual farms threatened by climate change and its variability. This service quantifies weather conditions into a "weather risk index" that is customized to the species of crops and its growth stage.

This service does not require additional technical resources. Instead, it fully takes advantage of the existing weather forecasts and analysis derived from the Korea Meteorological Administration (KMA). When the risk is severe enough to cause any damage to the crops, the Agro-meteorological Early Warning System is activated and the warning messages are delivered to the farmer's mobile phones. The messages are sent with proper solutions that farmers may utilize to protect their crops against potential damage (Fig. 1).The warning system is based on the comprehensive technologies including the scaling down of weather information to the field level and crop specific risk assessments.

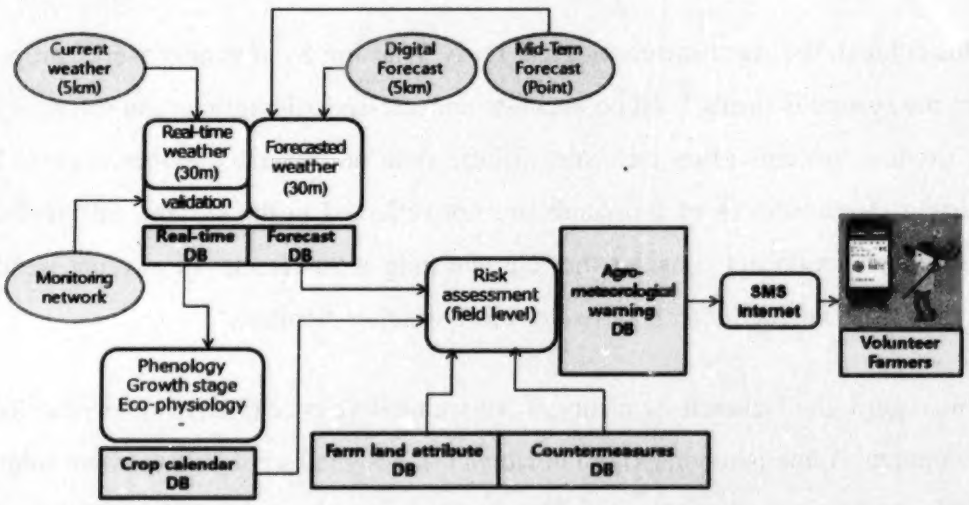

Fig.1. Information flow of the field-specific Agro-meteorological Early Warning System

Current Status

Currently, the technologies necessary to make the warning system more practical have been developed, including technologies for forecasting real-time weather conditions, scaling down of weather data to the individual farm level and risk assessments of specific crops. Furthermore, the scientific know-hows have been integrated into a web-based warning system. (http://www.agmet.kr) This service provides volunteer farmers with direct, one-on-one weather data and disaster warnings along with relevant solutions. In 2014, the service was put in operation in a rural catchment of 350 ㎢. Now in this area, 500 volunteer farmers who raise various crops are participating in this project to receive user-specific weather information from the service and in turn, provide feedback and evaluations to the NAAS.

Under the system, the likelihood of a disaster is calculated by the relative position of the current risk on the normal distribution. It is derived from climatologically normal year data collected from 840 catchments in Korea.

Future Plans

Empirical studies have been conducted since 2014 under the 4-year (2014-2017) plan to make this system fully operational. Under this plan, the system will be implemented in the Seomjin River Basin area, which is home to over 60,000 farms and orchards over 4,900km^2. Diverse experiences obtained through this study will be highly useful in planning and developing a nation-wide disaster early warning system for the agricultural sector. The system is a great leap forward in protecting agriculture exposed to the weather extremes under climate change and. This service system will be extended nation-wide starting in 2018.

Paper no. 4: South Africa

ISSUES RELATING TO AGRICULTURE

Document FCCC/SBSTA/2014/L 14

23 March 2015

1. Background

The Subsidiary Body for Scientific and Technological Advice (SBSTA), in accordance with its draft conclusions proposed by the Co-Chairs and agreed to by the Parties at SBSTA 40, held from 4-15 June 2014 in Bonn, Germany, invited Parties and admitted observer organizations to submit to the secretariat by 25 March 2015 their views on issues relating to the following elements:

a) Development of early warning systems and contingency plans in relation to extreme weather events and their effects.

b) Assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local level.

The SBSTA further requested the secretariat to compile them into a miscellaneous document for consideration at SBSTA 42 (June 2015).

2. Issues relating to Agriculture

South Africa welcomes the opportunity to submit its views on the issues relating to the elements referred to in paragraph 1(a) and (b) above.

2.1) Development of early warning systems and contingency plans in relation to extreme weather events and their effects.

An early warning is defined as the issuing of accurate and timely information from an identified and trusted source that is aimed at alerting the individuals at risk to avoid or minimise the impact of disaster. For agricultural purposes, early warning can be any information pertaining to any risk that might hamper agricultural production e.g. weather and climate conditions, pests and diseases, market prices etc.

To be effective and efficient, an Early Warning System must be multi-hazard, people-centered and must integrate the following four elements:-

- Knowledge of the risks faced;
- Prediction, technical monitoring and warning services;
- Dissemination of meaningful and timeous warnings;
- Awareness and preparedness to act (response capacity).

The necessary support should be provided in the development of effective and efficient early warning services by providing means of implementation.

i) Early Warning Systems (EWS) as an adaptation tool to climate change and its effects

Adaptation to climate change remains a top priority for most developing countries like South Africa. Smallholder farmers represent about 80 percent of sub-Saharan Africa's farming population, and suffer disproportionately in the face of droughts, floods and other weather-related events. Extreme weather events are becoming more frequent and more severe, threatening the reliability and productivity of agriculture, exacerbating already extreme levels of poverty, and reinforcing persistent inequity and chronic under-nutrition. These problems can only be solved through the widespread adoption of more resilient, productive, sustainable, equitable and increasingly efficient farming practices. Increasing the capacity in the disaster risk reduction field and prioritising training and awareness is essential to ensure that knowledge about potential hazards and usage of climate information is generally available.

The challenge is the often neglected elements which are warning dissemination and preparedness to act. Warnings may fail to reach those who need to take action and may not be understood or address their concerns. Possible root causes include: inadequate stakeholder commitment; poor coordination among various actors; lack of public participation and awareness in the development and operation of early warning systems and research not informing government policy.

The science community should consider creating platforms where users and end-users can interact in climate application discussions. It also has a critical role to play in the provision of specialized scientific and technical inputs to assist government and communities in developing early warning systems. Scientists should provide critical expertise in: continuous modeling to improve climate accuracy, analyzing natural hazard risks facing communities, supporting the design of scientific and systematic monitoring and warning services, supporting data exchange and translating scientific and technical information into understandable warnings for those at risk.

The role of local communities in effective early warning services should be strongly encouraged, as well as increased regional cooperation and better communication tailored to people's needs, more training, community preparedness, education and awareness raising to better protect vulnerable communities.

ii) Contingency plans in relation to extreme weather events and their effects.

Extreme weather events and their impacts are increasing at an alarming rate. The frequency and intensity of extreme weather events are expected to increase as a result of climate change and this will negatively affect agricultural productivity and food security. Recent model projections for South Africa generally indicate an increase in temperature and rainfall variability.

Proactive programmes and contingency plans with regard to extreme weather events and their effects need to be put in place. It is essential to ensure that provision is made for the periodic review and update of these plans. Contingency plans should articulate actions to prevent and reduce the risks and deal with

risk reduction measures in the long-term while managing emergencies in the shorter term, including aspects of preparedness, response and recovery. In addition attention needs to be given to regular monitoring and evaluation of programmes.

There is a further need for the contingency plans to include local knowledge and experience of farmers, women and the youth.

2.2) Assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local level.

Risk and vulnerability assessments have a lot of things in common. The assessment of risk and vulnerability to climate change requires good quality information. The information needed includes climate data, such as temperature, rainfall and the frequency of extreme events, and non-climatic data, such as the current situation for different sectors including water resources, soils, food security, human health, terrestrial ecosystems and agro-biodiversity. Ideally, the process of risk assessment should be synchronized with the planning process.

South Africa upholds the view that assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local level should be conducted and the results presented in an understandable manner. Furthermore, there is a need for collaborative partnerships with private sector, research and academic institutions. Equally important is that there is need to improve and continue to assess the means (including the institutional design and requirements) by which scientific knowledge and advanced technological products (e.g., early warning systems, seasonal forecasts) could be used to enhance the resilience of vulnerable communities in developing countries in order to improve their capacity to cope with the effects of climate change.

Recommendations

South Africa has identified the following critical areas that SBSTA needs to address in order to assist particularly developing countries with regard to the above, taking into account the diversity of their agricultural systems and the differences in scale:

- Provide access to scientific and technical information and means of implementation of early warning systems and contingency plans;
- Assist governments and communities with expertise in developing early warning systems and contingency plans in relation to extreme weather events and their effects;
- Identify innovative technology appropriate to reducing risk and vulnerabilities;
- Encourage the collaborative participation by farmers in any contingency plans in relation to extreme weather events and climate change that will affect them;
- Encourage collaborative partnerships with private sector, research and academic institutions;
- Recognise the role of rural and poor people, especially women and the youth, in the assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local level;

- Provide means of implementation to developing countries in the assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local level;
- Support research in addressing climate change related contingency planning, risk and vulnerability assessment and early warning systems.

Paper no. 5: Sudan on behalf of the African Group

SUBMISSION BY SUDAN ON BEHALF OF THE AFRICAN GROUP OF NEGOTIATORS (AGN)

ISSUES RELATED TO AGRICULTURE UNDER SBSTA

Africa makes this submission pursuant to the request made at the 40th Session of SBSTA to submit Parties' views, recalling Article 9 of the Convention, on the basis of the objective, principles and provisions of the Convention, in accordance with Decision 2/CP.17, paragraph 75, taking into account the conclusions of SBSTA 38, on the following areas:

(a) Development of early warning systems and contingency plans in relation to extreme weather events and its effects such as desertification, drought, floods, landslides, storm surge, soil erosion, and saline water intrusion;

(b) Assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local levels, including but not limited to pests and diseases.

A. EARLY WARNING SYSTEMS AND CONTIGENCY PLANS

Background

Africa is highly vulnerable to the negative impacts of climate variability and climate change owing to the high frequency and intensity of extreme climate events and the increasing risk of slow onset processes. Emerging empirical evidence from the Fifth Assessment Report of the IPCC (IPCC AR5) shows increased frequency of droughts, floods, rising temperatures, sea level rise, and other weather and climate events, pose major threats on populations that derive their livelihoods from these agricultural systems. For example, the droughtsin the Gambia of the Sahel region in 2013, according to Yaffa, led to a decline of 39% in groundnut, 45% in maize, 64% in millet, and 50% in rice production, respectively. In the Horn of Africa, the UNICEF reported in 2011 that 8.8 million people needed humanitarian support during the 2011 drought. According to the UNEP Report of 2009, droughts as a result of climate change have contributed to a reduction in the size and water levels of Lake Chad in West Africa by 95% in 2001, which resulted in increased poverty due to its direct impact on fisheries and food security. Other reports indicate that flood fatalities in Africa increased by a factor of ten from 1950 to 2009, and during the decade 2000-2009 have even doubled. The understanding, prediction and early warning of extreme climate events are therefore critical to climate risk reduction and sustainable development in Africa. Early warning system (EWS) is, "the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss."

In Africa many EWSs have been developed including the Continental Early Warning System of the AU, FewsNet, Nile Flooding Early Warning System, Regional Climate Outlook Forums for Southern Africa, East Africa and West Africa, among others, covering most types of natural hazards, conflicts, ecological changes, health-related and complex humanitarian crises. However, these systems are not working as expected due to a wide range of factors including data gaps, difficulties in accessing data where it is collected, lack of suitable early warning indicators that are

gender sensitive, inadequate data monitoring and observatories for agro-hydro-meteorological hazards, and inadequate mechanisms for multi-disciplinary and /or multi-agency coordination. Other barriers include the inability of regional, sub-regional and national systems to downscale regional level EWS products to the local level for actions, lack of institutional coordination structures, insufficient gender considerations, inadequate financial and human resources capacities, untimeliness, inaccuracy and unreliability of EW information.

At the national level, there are various EWS (see Appendix I). However, there are often no specific emergency response plans that consider hazard/risk levels and characteristics of vulnerable and marginalized groups including women, children, elderly and the physically challenged; limited political will of the benefits of early warning; inadequate feedback and improvement mechanisms of EWS; unclear and inconsistent EWS messages that have inadequate risk information and poor stakeholder engagement. Furthermore, it is recognized that there is inadequate risk awareness and hazard recognition and related emergency response actions. National governments also do not allocate adequate resources to support building of EWS capacities (human, financial, equipment, etc.) across national and local levels, for long-term sustainability.

Generally, contingency preparedness by institutions to respond to various hazards in a coordinated and integrated manner is far from the desired level. In most cases, while early warning signals may be issued in good time, response is often late, haphazard and reactive rather than proactive. Response is mostly curtailed by lack of clarity on the roles and responsibilities as well as collaboration and coordination by different institutions that should include the possibilities of gender-inclusive public-private-people partnerships (PPPP). On the other hand, public awareness about contingency plans is low, worsening the situation. While indigenous knowledge exists, it is not adequately integrated into contingency plans and disaster response strategies.

In order to address the short, medium and long-term challenges and barriers identified above, it is suggested that the following actions, categorized into the three tiers of policy, planning and practice, need to be undertaken as a matter of urgency at regional, sub-regional and national levels.

At the regional level:

Policy

- Strengthening regional forums and networks, such as the ICPAC's outlook forum for seasonal climate forecasts; SADC Climate Prediction Centre and FEWS net;
- Supporting regional institutional frameworks, policies and systems for monitoring and evaluating EWS in Africa to share and promote best practices;
- Enhancing regional systems that would remove barriers to the use and uptake of EWS messaging that would encompass
    - Packaging of information appropriately to meet the needs of end users
    - Timely access of EWS messages by end users

- Downscaling of regional information to local level for actual actions
- Building capacity of the coordinating institutions, including technical, financial and human;
- Improving trust in the EWS message and the messengers;

- Promoting and strengthening Public-Private-People Partnerships (PPPP) in the design and implementation of EWS.

Planning

- Supporting the implementation of a regional system for inventorying and documenting the current landscape of Early Warning Systems in Africa that would include
  - Various applications, including identification of hazards such as floods, drought, pests and diseases, seasonal rainfall, and other disasters;
  - Temporal scale for short- and long-term early warning;
  - Identification of the users of these systems;
  - Spatial scale of the systems regional, sub-regional and sub=national;
  - Purpose/objectives of the early warning systems;
- Establishing monitoring systems at all levels;
- Integrating agro-hydro advisories into regional EWSs;
- Developing a comprehensive list of adequate buffer stocks (food and materials) for multiple hazards.

Practice

- Enhancing regional systems that would address existing knowledge gaps, such as:
  - Inter-annual and intra-seasonal characterises of the rainfall onset, duration of the rains, wet and dry spells, cessation, and length of growing period;
  - Linkage of indigenous knowledge-based and scientific EWSs;
  - Understanding of the causes of inaction to EWS messages by stakeholders at all levels, from governments to communities;
  - Inadequate understanding of end user needs;
  - Impacts and measurement of benefits of EWSs;
- Strengthening communication strategies among EWS stakeholders at different levels,

At the sub-regional and national levels:

Policy

- **Promoting political will of the benefits of early warning that would be reflected in harmonized national and local management policies, planning, legislation and budgeting;**
- **Providing adequate financial resources to support disaster risk management;**
- **Promoting and strengthening Public-Private-People Partnerships in the design and implementation of EWS.**

Planning

- **Allocating adequate resources to build EWS capacities, including human, financial, equipment, etc., across national and local levels for long-term sustainability;**
- **Improving feedback mechanisms for contingency, Early Warning and response systems at all levels to provide systematic evaluation and ensure system improvement over time;**
- **Establishing monitoring systems at all levels;**
- **Establishing adequate buffer stocks for addressing multiple hazards.**
- **Establishing and strengthening microfinance and cooperative opportunities that include insurance schemes and social safety nets for crops, livestock, fisheries, and losses due to pests and diseases.**

Practices

- **Building systems that synergistically address hazard detection, monitoring and forecasting; risk analysis and incorporation of risk information in contingency planning and warnings; dissemination of timely and authoritative warnings; and community planning and preparedness with the ability to activate emergency plans to prepare and respond, coordinated across agencies at national to local levels;**
- **Identifying stakeholders, clearly defining their roles and responsibilities and coordination mechanisms within national and local plans, legislation, directives and memoranda of understanding;**
- **Producing EWS messages that are**
  - **Clear, consistent and that include risk information;**
  - **Designed to link threat levels to contingency preparedness and response actions using colour, flags, etc.;**
  - **Understood by authorities and end users; and**
  - **Issued from a single or unified, recognized and authoritative source;**

- Developing specific emergency response plans that consider hazard/risk levels, characteristics of the exposed communities, including urban and rural communities, and particularly vulnerable groups such as children, women, the elderly and the hospitalized;
- Creating risk awareness and training in risk management, hazard recognition and related contingency response actions integrated in various formal and informal educational programmes;
- Developing EWS through strengthening and integrating scientific and indigenous knowledge and capacities of women, men and the youth among other actors.

B. ASSESSMENT OF RISK AND VULNERABILITY OF AGRICULTURAL SYSTEMS IN AFRICA

Continental and Regional Level Aspects of Risk and Vulnerability of Agriculture in Africa

Agriculture systems, comprising crop, livestock, and fisheries production systems, continue to be the cornerstone of livelihoods and economies of Africa. There is growing evidence of risks and vulnerabilities of African agricultural and livelihood systems to climate change. Emerging empirical evidence from IPCC AR5 shows increased frequency of droughts, floods, rising temperatures, sea level rise, and other extreme weather events, posing major threats on populations that derive their livelihoods from these agricultural systems. For example, in South Africa, according to the UNEP/ICRAF 2009 Report, the drought in 2009 resulted to annual crop loss of between 10% to 50%. This resulted to food insecurity in the country. Further, according to Ramirez-Villegas and Thornton (2015), maize production in Africa is projected to decrease by 12% - 40%. According to the same authors, climate change is projected to reduce areas suitable for coffee production by about 50%.

According to a review by AfricaInteract (2013), climate variability may have devastating impacts on African economies. Water as a risk and vulnerability as reported by the same source indicates that water scarcity is expected to be limited for irrigation and other productive uses. Africa has introduced and adopted regional policies, e.g. the East African Community Climate Change Policy and ECOWAS Climate Change Policy, strategies, and institutions for environmental management. Still efforts are needed to streamline these policies and strategies in development plans. There are some limitations, however, to streamline these policies and strategies in development planning. These limitations are attributed to

(a) gaps in human capacity;

(b) limited financial resources;

(c) socio-economic factors including the gender differentiated impacts of extreme weather and climate events;

(d) the costs and benefits of adaptation response measures and coping strategies by small-scale farmers;

(e) type and availability of adaptation technologies; and

(f) in the scientific knowledge of climate change impacts on agriculture that have hitherto not been assessed, developed, and/or modelled either due to data limitations or short-comings in conceptualizing the problem. As such, non-action in addressing climate change risks and vulnerabilities will result in loss of livelihoods, migration, and insecurity in the region.

National and Local Level Aspects in African Countries

At national levels, Ethiopia, Uganda, Rwanda, Kenya, Malawi and the Gambia have undertaken, or are in the process of undertaking risk and vulnerability assessments of different sectors including in agriculture. Recognizing that agriculture holds the key to national sustainable and rural development, a top priority at the national and local levels now is how to feed the projected population increase in the respective countries. This task is especially formidable in most African countries, where close to 75% of the small-scale farmers directly or indirectly rely on rain-fed agriculture, fisheries and livestock as a source of livelihood. African countries' capacity to produce food is likely to be challenged by the combined impacts of natural resource degradation, exposure to climate risks and vulnerability of agricultural systems to different climate change scenarios at national and local levels, including but not limited to, pests and diseases, limited knowledge, information, and skills, and limited access to appropriate and climate change-friendly technologies. Thus, ensuring food security by reducing risks and vulnerabilities at the national and local levels requires urgent actions to improve the productivity and promote climate-resilience of agriculture including livestock and fisheries, and to enhance the food value chains to ensure adequate nutrient-rich and pollutants-free and affordable food supplies.

There are several gaps that do exist in Africa at the regional, national and sub national levels such as;

- Limited understanding of the precise risks and vulnerabilities for decision making;.
- Inadequate integration of risks and vulnerabilities in policy and institutional frameworks;
- Insufficient harmonization of climate data and information across the region;
- Inadequate climate-resilient water management knowledge for African agricultural systems;
- Inadequate knowledge of climate-related pests and diseases risks and vulnerabilities management for African agricultural systems;
- Inadequate consideration of gender issues addressing climate change-related risks and vulnerabilities;
- Inadequate participation of the private sector in assessment of risks and vulnerabilities of climate change-related agricultural systems.

In order to address the short, medium and long-term challenges and barriers identified above, it is suggested that the following actions, categorized into three tiers of policy, planning and practice, need to be undertaken as a matter of urgency at regional, sub-regional and national levels:

Policy

- Support policy harmonization and sectoral coordination in agriculture;

Planning

- Build institutional and human capacities to enhance research uptake, knowledge translation, and the use of appropriate tools at regional, national, and local levels;
- Review and recommend appropriate institutional setups;
- Integrate climate change risks and vulnerabilities into policy M&E mechanisms;
- Harmonize and validate climate data information across regions;
- Establish strong linkages between the national and regional climate and hydrological databases;
- Build institutional and human capacities to acquire the appropriate knowledge and skills to address the challenges of climate change risks and vulnerabilities including the challenges of climate-related pests and diseases as well as in water management for agriculture practices;
- Develop guidelines and analytical tools for better integration of gender issues into policies addressing climate risks and vulnerabilities in the agriculture sector;
- Develop and promote communication tools on gender integration into climate change risks and vulnerabilities of the agriculture sector;
- Identify entry points for increased participation of the private sector in the assessment of risks and vulnerabilities in agriculture;

Practice

- Support research and development to promote better understanding of risks and vulnerabilities of climate change on agricultural systems in Africa;
- Develop tools, guidelines, methodologies, and approaches to analyze climate data and assess the risks and vulnerabilities of African agricultural systems and water management at regional, national, and local levels;
- Strengthen national systems for collecting, analyzing, and disseminating risk and vulnerability data and information;
- Collect and establish accessible regional climate data bases;
- Identify measures to improve readiness for effective risk and vulnerability responses;
- Support research and development to promote better understanding of the trends as well as promote use of appropriate control and management methods for climate-related pest and diseases;
- Develop and support research and development to promote better understanding and integration of differentiated knowledge on risks and vulnerabilities of gender issues.

Paper no. 6: United States of America

Issues Related to Agriculture

24 March 2015

The United States welcomes the opportunity to submit its views and experiences, pursuant to FCCC/SBSTA/2014/L.14, on the following two areas: 1) Development of early warning systems and contingency plans in relation to extreme weather events and its effects such as desertification, drought, floods, landslides, storm surge, soil erosion, and saline water intrusion; and 2) Assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local levels, including but not limited to pests and diseases.

1) Development of early warning systems and contingency plans in relation to extreme weather events and its effects such as desertification, drought, floods, landslides, storm surge, soil erosion, and saline water intrusion

The United States believes that the ability to accurately predict weather patterns and communicate those patterns is important for all sectors of U.S. agriculture. Forecasting tools should rely on real-time data at a resolution that matters on a farm scale in order to drive planting decisions. Typically, producers tend to hear forecasting predictions from many different sources. Consolidating this information would improve producers' decision-making abilities.

Improving Drought Forecasts: Research, Warning, and Preparedness

Over the past fifteen years the United States has made significant progress in State and Federal drought policy and science. As recently as the late 1990's, policy makers had a six-month delay in receiving data on regional drought severity and many policy makers thought of the "drought season" as beginning in June. Our awareness of drought severity and our ability to monitor drought in real time have both improved dramatically over the past 15 years due to our ability to assimilate the vast array of data using a geographic information system, which in effect layers multiple datasets.

Through coordination between governmental and non-governmental partners a number of warning mechanisms have been put in place.

National Integrated Drought Information System

The National Integrated Drought Information System is an interagency and interstate effort to establish a national drought early warning information system. It provides better coordination of

monitoring, forecasting, and impact assessment efforts at many levels. Also it provides a better understanding of how and why droughts affect society. The National Integrated Drought Information System works with communities and existing networks through: drought assessments; climate outlook forums; education and outreach/webinars; engaging preparedness communities; and drought early warning systems in watersheds across the United States.

The United States Drought Monitor

The United States Drought Monitor, which has been in existence since 1999, consists of a partnership among the National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, and the National Drought Mitigation Center. Input is also received from other State, Federal and local entities. It is designed to explain drought in historical perspective to the public and decision makers. The Monitor is updated weekly using a variety of data-based drought indices. Currently it is used as a trigger mechanism for both State and Federal drought response measures.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration provides forecast summaries which include: one and three month temperature and precipitation outlooks; El Niño/Southern Oscillation updates; and monthly and seasonal drought outlooks. Also drought assessment groups meet jointly with U.S. Department of Agriculture and National Oceanic and Atmospheric Agency partners. There are regularly scheduled meeting in which information is shared with local producers.

Future Drought Prediction Research

Research under development in the United States includes:

- Improved understanding of drought development mechanisms
- Role of 'atmospheric rivers' and other phenomena in reducing drought severity and duration
- An improved assessment of drought monitoring based on verification metrics
- Impacts of decadal scale variations on seasonal forecast reliability
- Improved satellite estimates of snow cover (e.g. snow-water equivalent)
- Improved satellite estimates of soil moisture
- Improved predictions of precipitation
- Improved characterization of drought persistence and demise – likelihood for receiving the amount of precipitation necessary to either ameliorate or end the drought

SERVIR Regional Visualization and Monitoring System

SERVIR began operations in 2004 as a joint venture by the National Aeronautics and Space Administration, the U.S. Agency for International Development, the World Bank, and the Central American Commission for Environment and Development.

The SERVIR initiative integrates satellite observations, ground-based data and forecast models to monitor and forecast environmental changes and to improve response to natural disasters. SERVIR enables scientists, educators, project managers and policy implementers to better respond to a range of issues including disaster management, agricultural development, biodiversity conservation and climate change.

SERVIR emphasis is placed on partnerships to fortify the availability of searchable and viewable earth observations, measurements, animations, and analysis. A SERVIR coordination office and rapid prototyping facility is located at the National Aeronautics and Space Administration Marshall Space Flight Center in Huntsville, Alabama. Regional SERVIR hubs are located at the Water Center for the Humid Tropics of Latin America and the Caribbean, in Panama and the Regional Center for Mapping of Resources for Development, based in Kenya, and the International Center for Integrated Mountain Development located in Kathmandu, Nepal.

The SERVIR system helps nations in Mesoamerica, Africa, and the Himalayan regions cope with eight areas of societal benefit identified by the Group on Earth Observations: disasters, ecosystems, biodiversity, weather, water, climate, health, and agriculture. Decision makers use SERVIR to improve their ability to monitor air quality, extreme weather, biodiversity, and changes in land cover, and the system has been used over 35 times to respond to environmental threats such as wildfires, floods, landslides, and harmful algal blooms.

Famine Early Warning Systems Network (FEWS NET)

FEWS NET provides early warning and analysis on acute food insecurity. It was created in 1985 by the U.S. Agency for International Development. It provides objective, evidence-based analysis to help government decision-makers and relief agencies plan for and respond to humanitarian crises.

Analysts and specialists in 22 field offices work with U.S. government science agencies, national government ministries, international agencies, and non-governmental organizations to produce forward-looking reports on more than 36 of the world's most food-insecure countries. The FEWS NET team comprises five US government agencies: National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, U.S. Department of Agriculture, U.S. Geological Survey, and U.S. Agency for International Development), as well as two

private contractors, Chemonics International Inc. and its information technology partner, Kimetrica[1].

FEWS NET products include: monthly reports and maps detailing current and projected food insecurity; timely alerts on emerging or likely crises; and specialized reports on weather and climate, markets and trade, agricultural production, livelihoods, nutrition, and food assistance.

2) Assessment of risk and vulnerability of agricultural systems to different climate change scenarios at regional, national and local levels, including but not limited to pests and diseases

The United States believes risk and vulnerability assessments can enhance resilience within the overall agro ecosystem. Elucidation of the national perspective provides a framework for understanding the current climate change situation. Through national planning the United States is developing a wide variety of adaption options for both long- and short-term adaptation strategies and measures.

Technical Bulletin

In 2013 the U.S. Department of Agriculture (USDA) released *Climate Change and Agriculture in the United States: Effects and Adaptation, Technical Bulletin 1935*[2]. This technical bulletin offers extensive information on the state of U.S. agriculture and climate science, and details the effects of climate change on agricultural production, the economics of these effects, and potential adaptation strategies. It sums up the latest understanding of climate change effects on U.S. agriculture and explores the potential for adaptation strategies to minimize the costs and capitalize on the opportunities presented by a changing climate.

The bulletin offers seven key messages.

1) Projections for crops and livestock production systems reveal that climate change effects over the next 25 years will be mixed. Beyond midcentury, however, changes in climate are expected to have overall detrimental effects on most crops and livestock.

---

[1] Chemonics International Inc. manages FEWS NET's field offices and Washington, DC technical office. Kimetrica provides tools for knowledge and data management

[2] See http://www.usda.gov/oce/climate_change/effects_2012/effects_agriculture.htm

2) Increases of atmospheric carbon dioxide (CO2), rising temperatures, and altered precipitation patterns are affecting agricultural productivity and will continue to do so. Increases in temperature coupled with more variable precipitation reduce crop productivity and, over the longer-term, these effects will likely outweigh the benefits of increasing CO2. Effects vary among annual and perennial crops, and between regions; however, all production systems will be affected to some degree by climate change. Because agricultural systems depend upon reliable water sources, and because the pattern and potential magnitude of precipitation change are not well understood, there is considerable uncertainty in climate change assessment efforts.

3) The predicted higher incidence of extreme weather events will have an increasing influence on agricultural productivity. Extremes matter because agricultural productivity is driven largely by environmental conditions during critical threshold periods of crop and livestock development. Improved assessment of climate change effects on agricultural productivity and profitability requires greater integration of the timing and magnitude of extreme events into crop and economic models.

4) Livestock production systems are vulnerable to temperature stresses. An animal's ability to adjust its metabolic rate to cope with temperature extremes can lead to reduced productivity and in extreme cases, death. Prolonged exposure to extreme temperatures will also further increase production costs and productivity losses associated with all animal products, e.g., meat, eggs, and milk.

5) Climate change exacerbates indirect biotic stresses on agricultural plants and animals. Changing pressures associated with weeds, diseases, and insect pests, together with potential changes in timing and coincidence of pollinator lifecycles, will affect growth and yields. The potential magnitude of these effects is not yet well understood. For example, while some pest and insects will thrive under increasing air temperatures, warming temperatures may force others out of their current geographical ranges. Several weeds have shown a greater response to CO2 relative to crops; understanding these physiological and genetic responses may help guide future enhancements to weed management.

6) Multiple stressors, including climate change, increasingly compromise the ability of ecosystems to provide key ecosystem services. Agriculture is dependent on a wide range of ecosystem processes that support productivity, including maintenance of soil quality and regulation of water quality and quantity. Key near-term climate change effects on agricultural soil and water resources include the potential for increased soil erosion through extreme precipitation events, as well as regional and seasonal changes in the availability of water resources for both rain-fed and irrigated agriculture.

7) The vulnerability of agriculture to climate change depends upon the responses taken by people to mitigate greenhouse gas emissions and adapt to a changing climate. Mitigation efforts that slow the pace and intensity of climate change will reduce agricultural exposure to these changes, while effective adaptation increases agroecosystem resilience through actions that reduce sensitivity to climatic effects and increase production systems' adaptive capacity.

Adapting Strategies and Measures

Critical to the study of climate change and its effects on U.S. agriculture are considerations of adaptive strategies intended to enhance the resilience of the agroecosystem to climate change and variability, whereby agricultural producers, agribusiness, government personnel, and consumers make choices that both reduce costs related to climate change, as well as take advantage of any benefits presented by climate change.

In the United States an emerging approach to adaptation planning employs a spectrum of management intention and action – resistance, resilience, and transformation – that describes a successively greater change in the adaptive capacity of the agricultural system.

Resistance strategies seek to maintain the status quo in the near term through management actions that resist climate change disturbance but do not increase the adaptive capacity of the system. Resistance strategies can be costly, will likely increase in cost and difficulty over time, and may ultimately fail as climate change effects intensify.

Resilience strategies are typically actions that increase the adaptive capacity of the agroecosystem. These strategies seek to manage climate-related disturbances by enhancing the ability of the agroecosystem to moderate climate effects and to return to a healthy condition after a disturbance, either through natural processes or with minimal management intervention.

Transformation strategies facilitate the transition of the existing agroecosystem to a new agroecosystem with a different structure and function better suited to sustained production under rapidly changing climate conditions.

Adaptation strategies in use today by U.S. farmers coping with current changes in weather variability and a lengthening growing season include changing cultivar selection or timing of field operations, and increased use of pesticides to control higher pest pressures. Adaptation options for managing novel crop pest management challenges may involve new strategies for preventing rapid evolution of pest resistance to chemical control agents, the development of new pesticide products and improved pest and disease forecasting. Adaptation options that increase the resilience of agricultural systems to increased pest pressures include crop diversification and the

management of biodiversity at both field and landscape scale to suppress pest outbreaks and pathogen transmission.

Research on adaptation planning to increase the resilience of agriculture in California's Central Valley found that an integrated set of changes in crop mix, irrigation methods, fertilization practices, tillage practices, and land management was the most effective approach to managing projected climate risks in the near term. Given the projected effects of climate change, some U.S. agricultural systems, such as those currently operating at their southern marginal limit or those that currently depend on irrigation, will have to undergo more transformative changes to remain productive and profitable. These changes would involve a shift to a new product mix requiring substantial adjustments in management skills, field equipment, farm infrastructure, and/or marketing requirements.

Adaptation measures such as developing crop and livestock production systems robust to drought, pest, and heat stress, diversifying crop rotations, integrating livestock with crop production systems, improving soil quality, minimizing off-farm flow of nutrients and pesticides, and other practices typically associated with sustainable agriculture may increase the capacity of the agricultural system to remain productive under climate change. For example, drought and heat stress-resistant crops and livestock may improve the ability of farmers and ranchers to cope with the increases in variability of temperature and precipitation projected through mid-century. Similarly, production practices that enhance the ability of healthy soils to regulate water resource dynamics at the farm and watershed scales will be particularly critical for the maintenance of crop and livestock productivity under conditions of variable and extreme weather events. Enhancing the resilience of agriculture to climate change through adaptation strategies that promote the development of sustainable agriculture is a common multiple-benefit recommendation for agricultural adaptation planning.

National Agricultural Adaptation Planning

National agricultural adaptation planning in the United States includes strengthening climate-sensitive assets, integrating adaptation into relevant government policies, and addressing non-climate stressors that degrade adaptive capacity. Because of the uncertainties associated with climate change effects on agriculture and the complexity of adaptation processes, adaptive management strategies that facilitate the regular evaluation and revision of adaptation plans will help to ensure that agricultural systems remain productive under climate change. The need to move ahead with adaptation planning despite many uncertainties has driven research to develop robust adaptation strategies. Among these strategies, "no-regrets" adaptations may be of particular utility to agriculture. These are adaptations that are both cost effective under current

climate conditions and are likely to reduce specific risks associated with projected climate change effects. Synergies between mitigation and adaptation planning are also possible through the use of coherent climate policy frameworks that link issues such as carbon sequestration, greenhouse gas emissions, land-use change, regional water management, and the long-term sustainability of agricultural production systems.

U.S. Department of Agriculture Climate Hubs

The Climate Hubs were established in February of 2014 to deliver science-based knowledge, practical information and program support to farmers, ranchers, forest landowners, and resource managers to support climate-informed decision-making in light of the increased risks and vulnerabilities associated with a changing climate. These activities further the mission of maintaining and strengthening agricultural production, natural resource management, and rural economic development under increasing climate variability. Key partners in this effort include the public and land grant universities, Cooperative Extension, U.S. Department of Agriculture researchers, the private sector, state, local and regional governments, the National Oceanic and Atmospheric Administration, Department of Interior regional climate change experts, and non-profit organizations engaged in providing assistance to landowners.

The Climate Hubs are located at a USDA Agricultural Research Service or USDA Forest Service location. The Agricultural Research Service, Forest Service, and USDA Natural Resource Conservation Service provide the primary science and technical support. Furthermore, additional program delivery specialists on topics of relevance to a region will come from other U.S. Department of Agriculture agencies, including the Animal and Plant Health Inspection Service, Farm Service Agency, Rural Development, and the Risk Management Agency.

The Climate Hubs offer tools, strategies management options, and technical support to farmers, ranchers and forest land owners to help them adapt to climate change. The Climate Hubs direct land managers to USDA agencies that can provide program support to enable them to implement climate-informed management practices.

The Climate Hubs translate climate change projections into potential impacts on the agricultural and forestry sectors. Using this information, along with data on past trends, the Climate Hubs provide periodic regional assessments of risk and vulnerability in the agriculture and forestry sectors to help land managers better understand the potential direct and indirect impacts of a changing climate.

The Climate Hubs provide outreach, education and extension to farmers, ranchers, forest landowners, and rural communities on science-based risk management through the land grant universities, Cooperative Extension, USDA service agencies, and public/private partnerships.

Climate Hubs partners include universities; Cooperative Extension, USDA researchers, programs, and field offices; private sector companies addressing climate change adaptation and mitigation; farm groups; state, local and regional governments; tribes; National Oceanic and Atmospheric Administration and Department of Interior National regional climate change experts; and non-profits providing assistance to landowners. The Climate Hubs work to connect with and meet the needs of rural, tribal and underprivileged groups to help them sustain their working lands.

The National Oceanic and Atmospheric Administration Regional Integrated Sciences and Assessment Programs, and the Department of Interior Climate Science Centers and Landscape Conservation Cooperatives complement the U.S. Department of Agriculture Climate Hubs by providing data, findings, tools, and forecasts to build into integrated services for the agricultural and forestry sectors. In addition, all four regional climate networks are working together to coordinate stakeholder input into their programs.